

Use of Unmanned Air Vehicles (UAV) for Pipeline Surveillance to Improve Safety and Lower Cost

3rd QUARTERLY PUBLIC REPORT

Period: September through December 2005

Consolidated Research and Development for Pipeline Safety

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Background

This project tests available Small Unmanned Aerial Vehicles (SUAVs) and commercial sensor technologies to rapidly converge on a cost effective system solution to conduct aerial surveillance for pipeline monitoring and leak detection. The SUAV and sensor suite will be used to determine the feasibility of the application airborne remote sensing system for detecting leaks associated with natural gas and hazardous liquid pipelines, and identifying and recording encroachment violations in pipeline rights of way. Significant reduction in survey costs of aerial pipeline surveillance is an important aspect of this program. These practical solutions will address Department of Transportation priorities to close gaps in safety, inspection and enforcement while reducing the cost of state-of-the-art pipeline surveillance.



Figure 1: AeroVironment "Puma" Small Unmanned Aerial Vehicle



Figure 2: Launching of Raven Small UAV

The program team has assessed commercially available payload technology to determine the options available to meet mission requirements. Sensors, digital imagery and data processing options were reviewed. All options were screened for feasibility of use on remotely piloted flight. Sensors available, but not adequate for use to meet mission requirements without further technical development, were documented as well.

Summary of Progress this Quarter

Work this quarter focused on developing and finalizing a test plan to include a preliminary test of the available sensors and a follow on demonstration of the aircraft and sensor suite as well as conducting local testing of the sensors mounted on a small unmanned aircraft.

Results

Test Plan

The test plan set performance measurements for:

- Leak Detection
- Geographic Information System Application Testing

Leak Detection – One objective of the test phase of the program is to evaluate the applicability of utilizing commercially available sensors for both liquid and gas leak detection. The performance metric for leak detection will be based on the ability of the SUAV to find simulated gas and liquid hydrocarbon leaks. Individual tests will be recorded as a GO/NO GO.

Geographic Information System (GIS) Application Testing – The second objective of the test phase of the program is to evaluate the applicability of utilizing commercially available sensors for GIS applications. GIS application testing will focus on testing the ability and error of using a small UAV for:

- Determining the GPS location of the pipeline right of way
- Determining pinpoint GPS coordinates
- Monitoring encroachments into the pipeline right of way
- Conducting house counts

A complete Test Plan has been submitted to DOT OPS and is available for review.

Test Phase

The test phase of the project will include a payload proof of principal test, vehicle fabrication and testing (sensor integration and systems checks), and finally demonstration and analysis according the metrics.

The payload proof of principle testing took place in December 2005. The follow on vehicle integration and demonstration testing will be conducted in January-February 2006 with data analysis being conducted in February 2006.

Payload Proof of Principle

The payload proof of principal was conducted at the AeroVironment UAV facility over the period of one week in December 2005. It will be conducted in both the AeroVironment labs and flight test range.

Testing was conducted on the following payloads:

- Electro-Optical Camera
- Infrared Camera



Figure 3: Raven Small UAV used for payload proof of concept testing



Figure 4: Raven Pilot with Ground Control Unit

Electro-Optical Cameras – Electro-optical cameras (color and black & white) are currently in use on the military variant of the Puma SUAV. Proof of Principle testing focused on the pipeline monitoring applications for each camera type. Early results showed that it was possible to visually see pipelines and identify potential encroachment violations from a small UAV. Specifically, the following targets were clearly identifiable using current color cameras:

- Pipelines and associate equipment (pump jacks, storage tanks, etc.)
- Dead vegetation (leak detection)
- Construction equipment (encroachment)
- Agricultural fields (encroachment)
- Buildings (house counts)

No identifiable gain was made by using black and white cameras vs. color cameras. Thus, color cameras will be used for the demonstration phase.

Forward looking vs. side looking cameras were tentatively evaluated for their performance in monitoring pipelines. Forward looking cameras were good for flying right-of-ways while side looking cameras were advantageous for circling a target for continuous monitoring (i.e. encroachment and leak monitoring). Both forward looking and side looking cameras will be used in the demonstration phase for further evaluation.

Infrared – The infrared camera testing focused on determining the ability of using infra-red video during daytime and low light conditions for observing:

- Changes in ground temperature (leak detection)
- Construction equipment (encroachment)
- Buildings (house counts)

The infrared cameras could clearly identify engine heat from vehicles (potential encroachment detection) in both day and low light conditions. Additionally, the infra-red camera was able to distinguish liquid hot spots against the ground (used water heated to 90 degrees F) as a potential method for detecting liquid leaks.

Note: LIDAR – hand held LIDAR payload was unable to be tested due to equipment delivery delays between the supplier and AeroVironment.

Vehicle Fabrication

The vehicle fabrication phase of the program (January 2006) will focus on the checkout of the SUAV and final integration of the payloads.

Demonstration

The Demonstration phase of the project will be a real time trial of the SUAV and selected sensors and their ability to detect pipeline leaks, monitor encroachment, and conduct house counts. The demonstrations will be conducted over a one week period in January/February 2006, at the AeroVironment flight test facility and select off site areas. A thorough evaluation of the SUAV and selected payloads will be conducted for each mission.

Future Activities

The next quarter will focus on the following areas:

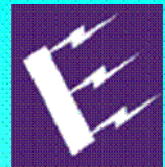
- Vehicle modifications to meet program requirements
- Conduct a series of deployments and demonstrations to evaluate the current sensor and platform abilities to conduct pipeline surveillance missions
- Conduct data analysis following demonstration/evaluation
- Submit the fourth quarterly report

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